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MANAGEMENT PRACTICES FOR SUSTAINABILITY OF SMALL, TECHNOLOGY-ORIENTED BUSINESSES

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Management Practices for Sustainability of Small Technology Oriented Businesses

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THESIS

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DEDICATION

To my wonderful wife, Cathy: For her love, unconditional support and encouragement thru difficult times for her.

To my children, Anya and Brayden: For being my source of strength and motivation.

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ABSTRACT

Management Practices for Sustainability of Small, Technology Oriented Businesses

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The focal point for this research is a drilling automation small business. Questions regarding survival, growth, innovation, flexibility and professional management related to this technology business are seeded as the root for the research. Topics were selected based on the experience of the author as an attempt to provide answers to such questions.

In a broader context, small businesses make an important contribution to the economy and job creation. Low survival rates raise questions about the factors that influence the success or failure of such businesses. Researches have attempted to identify such factors. However, there are limited theoretical models that were generated based on a small business setting.

Many factors and their interactions among each other could determine the survival of a small business. However, there are techniques and philosophies that enhance the potential for success. Some of those techniques and philosophies proposed by authors researched are the Lean Startup methodology, analysis of

roadblocks and speed bumps on the Product Development Process model, participative management, competencies alignment and outsourcing. Correlations between the small drilling automation business and research are made in order to generate the answers to the questions proposed initially.

Ultimately, in regard to the company I work for, generation of intellectual property via outsourcing, deep knowledge of the potential market, financial flexibility obtained from capital and other resources by means of the relationships established helped the company to survive startup and grow. Founding expertise translated into good behavioral focus supported a sustained growth stage and competitiveness. There are applicable models and methodologies that serve to guide to faster innovation where associated risks are managed by having the multiple solutions available. The level of informality tolerated within the firm should be related to the level of performance, so for us there may be benefit to a more formal evaluation of the strategy, uncovering relationships and details not anticipated, that could lead to different decisions. Overcoming capital restraints to earn financial flexibility was particularly beneficial to our initial success. At current size and complexity level, it would be beneficial for our company to evaluate more formal tactical management.

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CHAPTER 1. INTRODUCTION

After joining two visionaries in their drilling technology startup business shortly after it's conception, I have been fortunate to observe and participate in the efforts of all the original team members and those that have joined the company as the complexity of operations increased. After close to a decade, this small business of less than 50 employees has not only survived but also established a strong presence in the directional drilling automation field while keeping many of the entrepreneurial aspects that made the endeavor initially successful.

After all this time that the business continues to grow at a healthy pace, we ask ourselves the following questions:

1. What are the likely factors that helped the company to survive startup and take off?
2. What are the factors that influenced a sustained growth stage and ensured competitiveness?
3. How does the small business sustain innovation in the long run, even when it becomes a larger organization?
4. Is the informality practiced with various processes within the company appropriate?
5. Is having a flexible organization in a small business beneficial for its performance?
6. In which growth stage is the introduction of formal and trained management required?

In order to answer the questions presented above and provide better overall understanding of the issues, a broad number of literature resources from academia,

government and industry experts have been analyzed. Links between the ideas proposed by the authors have been identified and commonalities drawn to strengthen the validity of such ideas. Personal experience and that of colleagues was taken into account to establish a hypothetical baseline to facilitate and narrow down the research scope. The main focus of this thesis will be to provide a better understanding of the factors that contributed to the current success of the drilling automation small business and to identify potential areas of opportunity to sustain or improve future performance.

SMALL BUSINESSES IMPORTANCE

As we contemplate the subject of the thesis, the questions could arise as to what defines a small business and why is this analysis even important? Starting and running a small business is challenging in many ways, just as it is to become sustainable in the long term and continue growing. The importance that small businesses have in the economy triggers the interest of academia and industry experts to do research in this field. Understanding such importance and the challenges will facilitate placing our drilling automation business in a broader small businesses context.

There are several classifications of small businesses, and many of them share multiple commonalities around development. Among the classifications are ones with a core of technology development and/or its application to other non-technological business objectives. Scientists and engineers will always be behind the scenes, and there will be always a very important role for those that are involved with technology management.

The summary of common standards to be classified a small business as defined by the U.S. Small Business Administration under Title 13, Code of Federal Regulations, part 121.[1, 2]. are quoted[3] below:

- 500 employees or less for most manufacturing and mining industries, and
- $7 million in average annual receipts or less for most non-manufacturing industries.

The same agency published the following facts about the importance of the small businesses to the United States economy [4],[5]:

- Small businesses represent 99.7 percent of all employer firms.
- Small businesses employ just over half of all private sector employees.
- Small businesses pay 44 percent of total U.S. private payroll.
- Small businesses have generated 64 percent of net new jobs over the past 15 years.
- Small businesses create more than half of the nonfarm private gross domestic product (GDP).
- Small businesses hire 40 percent of high tech workers (such as scientists, engineers, and computer programmers).
- Small businesses are 52 percent home-based and 2 percent franchises.
- Small businesses made up 97.3 percent of all identified exporters and produced 30.2 percent of the known export value in fiscal year 2007.
- Small businesses produce 13 times more patents per employee than large patenting firms; these patents are twice as likely as large firm patents to be among the one percent most cited.

Below, the United States Small Business Administration explains about the survival rate for small firms (quote):

> Seven out of ten new employer firms last at least two years, and about half survive five years. More specifically, according to new Census data, 69 percent of new employer establishments born to new firms in 2000 survived at least two years, and 51 percent survived five or more years. Firms born in 1990 had very similar survival rates. With most firms starting small, small firms started 99.8 percent of the new employer establishments. Survival rates were similar across states and major industries.

Historically, small businesses have generated some of the most innovative engineering ideas, creating new jobs and benefits to the economy in general. However, there could be management mistakes or misses that could lead such businesses and innovations to failure. Given the importance of small businesses to the U.S. economy and the alarming low survival rates, it is imperative to gain better understanding of the factors and managerial practices that contribute to the success or failure of small technology businesses. In particular to our drilling automation business, the facts presented above suggest that some good decisions have been made given the good health of the business. As we continue, we will make an attempt to identify such decisions.

ENTREPRENEURIAL ORIENTATION VERSUS SMALL BUSINESS ORIENTATION

Now we will also take a look at entrepreneurial orientation in general and relative to our case company to better refine what that business looks like. Runyan et al. [6] performed a study trying to find the connections that the entrepreneurial orientation or small business orientation have on the performance of small companies. From their literature research, they found that entrepreneurial orientation is associated with positive trends towards innovation, proactivity and risk taking. On the other hand, they found several conceptions of small business orientation that are associated with less innovative behavior, high regards towards

personal goals or work/life balance. They view these two orientations as different concepts rather than inverses of each other.

Runyan et al. found that in the case of entrepreneurial and small business orientations, the performance effectiveness is not measured in the same way. In the business literature, the measurement of performance is typically associated with growth and financial achievements according to the authors. However, when owners have a small business orientation, the goals might be personal, rather than operative, perhaps with the attainment of a healthy income in order to survive, the authors explain. Therefore, the performance metrics in such businesses will be defined as the achievement of the goals defined within each business. With this justification, Runyan et al. designed a more subjective set of survey questions about the overall performance relative to the previous year, the competition and other companies alike. The authors' research suggests an accurate correlation of financial performance with the measurement of subjective indicators as mentioned above, even when no financial details are asked.

Runyan et al. were able to confirm that small business and entrepreneurial orientations are different approaches (differences highlighted above in Table 1) adopted by many different types of small businesses. Unexpectedly, they also found that small business orientation had a higher impact on performance than entrepreneurial orientation from their sampling of 267 small businesses. This discovery goes against existing literature backing entrepreneurship orientation as a strong factor of performance.

Another key finding by Runyan et al. has to do with the age or prolonged existence of the small business. From their study results, entrepreneurial orientation was more relevant to the impact on performance for companies with

less than 11 years in business. For older companies, small business orientation was higher in relevance. The authors suggest a direct association of the owners' accomplishments with emotional attachment to the business and balance of life as time progresses within such businesses. They imply that owners might suffer a natural evolution from one orientation to the other where entrepreneurship mindset comes first.

Table 1 summarizes the main differences between entrepreneurial and small business orientations. Note that while entrepreneurial orientation is highly driven by innovation, growth and financial achievement, the researcher found that their actual performance was lower than that of those with small business orientation.

	Entrepreneurial Orientation	**Small Business Orientation**
Conceptions	Innovation, proactivity and risk taking	Less innovative behavior, high regards towards personal goals or work/life balance. Emotional attachment
Performance Metrics	Growth and financial achievements	Personal goals, rather than operative. Healthy income in order to survive. Life/Work balance
Age for Relevance on Performance	Less than 11 years	More than 11 years
Actual Performance surveyed	*Lower*	*Higher*

Table 1. Entrepreneurial and Small Business orientations summary

Relating Runyan et al.'s findings to our drilling automation business, the firm has been operating for over 10 years from the startup stage. The orientation adopted for this business has been entrepreneurial, focusing on growth and financial performance. After the merger with a large drilling services company, the ownership of the company has changed. However, it still operates with the same entrepreneurial orientation and targets of a smaller business unit. In spite of

cyclical market dips, the company continues to perform positively and is expected to continue meeting financial goals in the future. Our business aligns with the concepts of entrepreneurial orientation, however we do not align with lower actual performance as Runyan et al. determined in their survey.

Compton [7] observed that the size of the company is not the main factor that determines whether an entrepreneurial approach can be adopted. Even when in large companies the resistance is greater, the attitude towards innovation, change and unconventional thinking is what fosters the entrepreneurial mindset.

This last statement has been true in our business; the entrepreneurial attitude of our business unit has endured any external intervention after two mergers before the last. The internal change agent (More in Chapter 4) or operation manager still encourages innovation and unconventional thinking relative to a larger company approach. This mindset is likely to be a key factor for the higher dynamic orientation to deliver value on a shorter-term basis and perhaps cohesiveness on our development team.

MANAGEMENT PHILOSOPHIES

The last grounding concept we will review is management philosophy and how that pertains to the case company again.

Dale Compton [7] explains that the management philosophy seems to have commonalities when companies are compared depending of the type and size as shown on Table 2 below. Note how generic entrepreneurial companies have closer commonalities with high-tech companies regardless of their size.

Large National/Multinational Mature Companies	**High-Tech Companies (Large or Small)**
Experience difficulty in being entrepreneurial Multi-disciplinary teams may be difficult Technology often focuses on development and continuous improvement	May or may not be entrepreneurial Multi-disciplinary team are frequent Technology derived internally or externally

Small Mature Companies	**Entrepreneurial Companies**
Entrepreneurship is uncommon Small size fosters multidisciplinary teams Technology often derived externally	Emphasize entrepreneurial approach Multi-disciplinary teams are common Technology often derived internally

Table 2. Some common characteristics of companies of different sizes and types (Compton 1997) [7]

Our small business has a strong entrepreneurial approach, multidisciplinary teams and the technology is derived internally, fitting in the "Entrepreneurial" and "High-Tech" management philosophies. Our business has survived over 10 years from its conception. It has still not reached 50 total employees. According to the data from the Small Business Administration, the firm clearly fits under the small business category and has passed the critical survival time threshold. This fact makes evident that a combination of factors and practices have influenced the relative success that the company enjoys at the present time. In the following chapters, some of those factors and practices will be analyzed, including a

perspective about the literature available. The literature found on this regard shows the abundance and diversity of topics about small businesses issues. We will address a sample of such literature that was found meaningful for the thesis herein.

CHAPTER 2. SMALL BUSINESSES RESEARCH CHALLENGES

For this thesis, the main source of data for the research was academic and empirical literature that combines management topics related to entrepreneurship, growth, innovation, agility and engineering. From a collection of 150 references, 20 were selected to be relevant to our questions proposed in the introduction of this thesis. Given the variety of topics and abundance of sources on small businesses, it was a very challenging task to make the right selections. As I went deeper in the research, I found that some of the authors make some observations on the small businesses research available as a whole, finding it scarce or insufficient in spite of the large number of titles related. For this thesis, it is important to have a sense of validity of the information collected since such material will be used to gain better understanding about our drilling automation business. We attempted to balance the academic and expert sources to provide a broader perspective.

DEVELOPMENTS VS. THEORETICAL TESTING

Tan et al [8] reveal the need to expand the research and development of theory to understand the small business setting involving technology. Their findings indicate that literature with new theory centered on small business context is scarce. From 25 years worth of literature reviewed, they have identified an evolution of the concerns derived from the differentiation of small businesses and entrepreneurial businesses, the significance of such businesses in the society, and the concerns about the characteristics and tactics that would lead to success. Unfortunately, a much larger proportion of documents addressing small businesses are devoted to theory testing (quantitative) rather than theory creation (conceptual).

Jones et al. [9] discusses findings from Atherton and Hannon [10] concerning the insufficient research on innovation management in small firms. They specifically describe a trend that the available research focuses on product development issues rather than the less evident small business issues like awareness development and capability building.

TRANSFERABILITY OF LARGE BUSINESS RESEARCH INTO SMALL BUSINESSES

The authors describe that there has been inconsistency of the quality of research into business management for which theories developed for larger businesses are tested on the small business context. Such quality of research has generated assorted views about the transferability and validity of such large business management theories applied to small ones. One of the problems that they have identified with small business management research is that researchers have been trained on certain theories and methods applied typically to traditional contexts like large businesses. Whenever research is done about small businesses, the traditional theoretical background and methodologies are often "forcibly" applied to the small business setting. Tan et al. find a supporting statement by Welsh and White [11] quoted as follows:

> …small entrepreneurial businesses are not just little big businesses, but are rather distinctive agents of change relative to larger, older firms

I believe that the adaptability of large business models have to be very carefully analyzed. I have observed engineers confused about normal or customary business practices and actual needs. Unless it makes business sense by the provision of solutions, is needed for rules compliance or is meant to add value, it would be a mistake to invest efforts and resources in implementing business or managerial practices just because it is customary on larger businesses.

REPEATABILITY AND VALIDITY OF EMPIRICAL RESEARCH

There is difficulty finding repetition and thus validation on a lot of the empirical business management research. According to Tan et al. [8], the source of this issue is the reluctance to repeat research already done in the past. They argue that this reluctance makes business management research rather informal compared to other academic areas in which a more scientific approach is followed. In other words, the results obtained from certain research should be repeatable and verifiable to be deemed credible.

As a result, they propose to apply the right theories and the right methodologies existing from other traditional fields to the small business framework. Ultimately, existing theories get tested and validated within the new setting, and/or new theories get originated from new knowledge obtained from the small business context.

Given the observations above, we gave preference to academic oriented books and journals over more commercial literature as a way to maybe enhance the formality of our research. We expect that such material will provide better stronger validation to the answers of our questions proposed about our drilling automation business.

CHAPTER 3.FACTORS OF GROWTH FOR SMALL BUSINESSES

One of the key interests of our drilling automation business is to have a long-term growth pace. Until last year, the business saw an aggressive increase in activity. The operations experienced significant expansion, and an important presence in the industry within our specialty was achieved. Due to the latest drop in the natural gas price, there has been a sharp decline of drilling activity for that product in the United States where most of our operations are concentrated. As a result of that market event and because of a surge of competition, our business and many more related to drilling activities have suffered a decline of activity. Even with this situation, our business retains the biggest market share of the specialty. However, new strategies have been implemented in order to address the market environment and a surge of new growth is expected.

GROWTH CONTINUUM

Jones et al. [9] found a perception of the growth of small businesses as an ascending continuum rather than phases or steps. Across such continuum, the dissimilarities between large and small become less prominent. The authors regard the phases concept found in the literature as weaker. Nonetheless, they concur about the description of each phase for the major attributes of the small businesses during such stages assuming a continuum in between. Such phases are:

I. Start-up
II. Survival
    - Operational Concerns focus
III. Success

- Tactics Concerns focus

IV. Take-off

- Strategy Concerns focus

From the phase theory above, I believe that our business could fit in the take-off stage. New technology development and new marketing strategies are currently in place in order to continue growing. Following, we make an exploration on the literature about commonalities and differences of small businesses that could influence growth.

COMMONALITIES AMONG HIGH GROWTH SMALL BUSINESSES

A study by Chan, Bhargava and Street [12] has an interesting approach to explain what successful small businesses have in common. So far, we have concentrated on small businesses with a technology core. However, for the research presented, it is of great interest to understand whether the success is independent of the type of industry.

The authors of the study mentioned above found supporting data that suggests that, by nature, small businesses have many different approaches in the initial organization capability close to business startup. Nonetheless, as a higher degree of performance is attained and sustained, more similarities are found among the general organizational capabilities of firms. In particular, the focus of the study was to determine whether organizational challenges are independent of the number of employees, annual revenue or type of industry.

This empirical study was based on a survey targeted to the owners or CEOs of the winners and qualifiers of the "Best 50 Companies Managed in Canada" award. The survey included a fixed questionnaire and an open question where they were

asked to summarize their three main organizational challenges. Answers were categorized and analyzed in order to produce numeric correlations among them. Some limitations are expected of this study in connection with the categorization process (interpretation) and the fact that the survey was concentrated on Canadian companies.

The main categories of identified organizational challenges among the companies surveyed are the following:

- Customer Management
- Managing Business Growth and Development
- Financial Management
- Leadership
- Human Resource Management
- External Environment

From the challenges identified above, it can be noted that they have a relationship with managing increased business complexity linked to growth. Amid the observations of this study was the fact that the challenges in leadership decrease as the businesses grow. They discussed that this could be due to the transformation from direct supervision to indirect control (See Professional Management in Chapter 4 for detailed discussion). Oppositely, external environment concerns increase, possibly due to a higher number of customers, competition and partnerships. But in general, the data supports the commonalities of high-growth businesses in the sample they analyzed.

By relating the common organizational challenges found in the study with our drilling automation business, we have noticed that in order to handle the increased complexities of customer handling, human resources and financial

management, we have relied on the addition of management staff and the integration of more sophisticated tracking systems. Joining a larger company provided some systems, and others are custom in-house developed systems. Even though we became part of a significantly larger corporation, most of the operations and decision-making activities are carried out as an independent business unit, preserving the majority of the small business aspects and challenges. Some of the processes inherited by the larger corporation were mandatory, but others were actually selected and utilized with minimal or no modifications. In our case, since our business requires its own specific management techniques that are different from the larger firm, the additional challenge for us is to make sure that processes inherited from the larger company do not disrupt our operations while still complying with their general policies.

As mentioned earlier, a decline of gas drilling activities affected our bottom line in a significant way. Our latest concerns are focused on the external environment and the strategy to recover the privileged position we had recently in our niche.

Jones et al. [9] observe several factors that are commonly observed in high growth rate ventures. Samples of these factors are listed below:

1. Financial data forecasting (cash flow, profit, sales)
2. R&D intensity and technological/market leadership strategy
3. Resource fulfillment
    a. Financial
    b. Technological
    c. Human
4. Flexible managerial structures enabling market responsiveness

5. Higher dependency on third party knowledge providers due to limited research and development engagement
6. Higher priority given to tacit knowledge rather than formal intellectual property protection
7. High dynamics and responsiveness thru continuous innovation and prevention of the creation of rigidity, allowing to address market opportunities and customer needs faster than bigger companies
8. Scarcity of trained and experienced people as the foremost constraint for fast growth
9. Remote locations
10. Mature sectors where it is difficult to attract labor
11. Flat organizations with strong communication, involvement and functional division

Relating the list above to our drilling automation business, we find a strong match, especially on "positive" points 2, 6, 7 and 11. On the "negative" points 8, 9 and 10 we also find strong correlation. Field operations require highly technically skilled people in order to handle electrical installations, software configuration and understand the complexities of directional drilling. Additionally it is required to have strong communications skills to train the end users under extreme pressure. Since these activities happen at very harsh and remote locations, people retention is notably difficult and a lot of turnover happens. Reaching the expertise level desired takes a long time, hurting the business every time someone leaves. People with the qualifications and personality desired are hard to come across and retain.

Small Businesses Commonalities and Differences with Larger Businesses

In their work about strategic management for Small and Medium Enterprises referenced by Jones et al. [9], Alan Marsden and Carole Forbes propose a general concept of the main differentiators of small businesses from large firms:

- Centrality of the owner-manager
    - E.g. Strongest authority, less delegation
- Informality of structure
    - E.g. Multitasking, overlap
- Limited resource base
    - E.g. Dependence on owners' and investors' capital. Especially at startup.
- Number of products produced (fewer)
    - E.g. Limited resources for Research and Development
- Range of markets served (fewer)
    - E.g. Tied to products produced and limitations on business expertise.

Marsden and Forbes [9] deduce from their findings that, on the strategy-making practices, there are no significant dissimilarities between small and large firms and that business models developed for competitiveness and strategy-making in large business could be adapted to small ones. They argue that concepts of Human Resource Management (HRM) and supply chain management could be adapted as well and have relevance towards performance improvement.

On this topic, Jones et al. [9] points to the Minnesota Innovation Research program focused mainly on larger, high technology companies over 17 years. From

that work there were found some common elements among large and small business settings:

- The allocation of resources and detailed innovation planning after the 'gestational' period of the SME concludes
- The expectations of plan changes due to setbacks during projects execution
- The contributions of the projects fluctuate rather than remaining steady (even in larger and resourceful companies)
- In innovation teams:
    - Staff working partial time
    - Elevated turnover rate
    - Lack of innovation experience regardless of skills

Advantages of Small Businesses Over Large Businesses

Feldman [13], in her investigation of small businesses' success towards innovation, refers to several advantages that small businesses compare with large businesses. The close relationship and collaboration that small businesses commonly develop with customers, suppliers, research agencies and other organizations strengthens innovation. In this case, she indicates that location proximity among these organizations facilitates the interaction.

Concluding with Feldman's study, she identifies that technical uniqueness and specialization constitute a niche that small businesses possess as an advantage over large companies. The reason is that large companies struggle to make profit out of such specialization, again corroborating the hypothesis that large companies

achieve high growth based on production intensity as opposed to technology intensity. (Peregrine Analytics LLC)

Small businesses aspiring to become large businesses (Entrepreneurial Orientation) could benefit from adopting general management and strategic techniques in earlier stages if relevant and value adding. Taking advantage of the specialization level is very important. However, as the adoption level of our products and services increases, there will be demand for more sophisticated and comprehensive solutions. Flourishing competition will also force us to innovate so that we can defend our market share. A lot of the knowledge and expertise originated around large businesses should serve as leverage to focus on the really important matters on our small businesses without the need to reinvent the wheel. Every business, small or large, will have specific problems and ways to solve them. The key is to learn from as many sources as are available and to identify many possible solutions and pick the best ones for our organization.

CHAPTER 4. ORGANIZATIONAL FACTORS IN SMALL BUSINESSES

Any business, regardless of size or specialty, will need people as the most precious resource to succeed. Even when businesses hire the best people, the way they are organized around the activities will play a critical role on the bottom line. For this thesis, we are seeking to understand approaches to organize the people that could contribute to the performance of the business. This will give us a baseline to understand whether our directional drilling business had the right organization to reach the current performance and what are the expectations as we grow even more.

ORGANIZATION STRUCTURE FACTORS

Technology Intensity vs. Production Intensity

In 2006, Eckhardt et al. released a study [14] in which the results suggest that a high growth pattern in new small businesses is directly related to the level of technology intensity in the form of innovation or application of technology. They consider technology intensity as one of the variables for the study. It is measured as the employment of engineers and scientists in such small businesses.

On the other hand, the data of this study also suggests that as large organizations increase production intensity or employment in production activities, large companies show a pattern of high growth. However, production intensity does not seem to enhance the growth rate of small businesses, and technology intensity will not manifest as high growth in large enterprises.

Eckhardt et al. present several theories and hypotheses supporting their findings described above. They conclude that depending on their needs, customers will reward certain routines adopted by small and large organizations. For instance,

customers will reward production intense organizations whenever reliability and repeatability is required. In this case, reduced variation in the processes, well defined organizational and information processing structures and monitoring mechanisms are required in order to heighten reliability. Nevertheless, in a technological environment, creativity and adaptability are rewarded whenever innovation and application of technology is priority.

From personal observation, reliability and repeatability not only could apply to production intense businesses but also to technical service business in which clients expect consistent levels of service, particularly when clients are production intense businesses. For example, our small business services large companies like drilling operators and rig contractors. One of the critical aspects of the level of service is the ability to exchange equipment on any kind of rig with minimal issues. As a result the standardization and maintenance operation of our equipment ensures repeatability and consistency of service for such large clients.

An example of the combination of the need for reliability, creativity and innovation is the system integration businesses. It is common for this kind of venture to design, implement and deliver custom turnkey technological solutions to their customers. However, it is expected that with every new project, standards of skills and expertise, project management, documentation and quality are consistently reliable and repeatable.

Flexibility Alignment to Industry Demand

Earlier, it was established that small businesses are able to achieve greater performance as their technology intensity or cumulative scientist and engineer employment is increased. Also, since small businesses have a more informal

structure, they are more prone to adapt to technology changes than large businesses. Verdu, Llorens and Garcia [15] challenge this theory by expanding the understanding of flexibility. They describe that the industry environment (external) will set the necessary level of flexibility in order to perform. Note the similarity with the concept of technology and production intensity by Eckhardt et al. [14] introduced earlier in this chapter. However, the actual level of internal flexibility might be above or below the level required by the industry. Both scenarios could have negative effects. For instance, a high level of flexibility (as of adaptability) implies higher costs, and lower level of flexibility might hinder the ability to follow industry trends (Flexibility is measured as a perception by the management body.). As a result, alignment between the desired and actual flexibility is desired to maximize performance. On the other hand, the industrial environment changes over time along with the flexibility demand. They found that the ability to adapt to new demands over time is directly related to the learning system. This represents the capacity to be flexible over time, called metaflexibility. Correspondingly, the capacity to change is the flexibility itself.

Verdu et al [15] attempt to quantify different types of flexibility including financial, operational, strategic and structural (flexibility mix) in addition to metaflexibility and performance. In their first hypothesis, the idea of large businesses being less flexible because of a more formal structure and information processing systems is put into perspective. Large businesses have more financial flexibility that makes them able to more easily afford the changes demanded by the environment. Small businesses in the early stages ahead of the establishment point typically have less access to financing and venture capital due to less credibility than larger firms with more established success. In their second hypothesis they suggest

that small companies have higher metaflexibility but their lower financial flexibility will obstruct the high growth rate. However the data did not show a significant difference in metaflexibility between small and large companies.

In other words, small businesses might have a lighter or leaner structure which thrives on less organizational inertia allowing them to be able to adapt by modifying such structure. Conversely, larger businesses with greater financial flexibility might have increased strength to be able to reorganize their structures even with greater inertia compared to small businesses. Nevertheless, the results of their study show that for small businesses higher performance is achieved when the required and actual flexibility are aligned or fitted with the requirements of the industry. For large businesses, performance was more attached to financial flexibility.

A perceived advantage for small businesses has been their capability to react to market changes in faster ways than larger businesses. Jones et al. [9]explain that a key element for this response ability is flexibility that represents the most important factor to remain competitive. The authors suggest that in order to preserve such flexibility, entrepreneurs should consciously maintain flexible processes and structure whenever there are adjustments. Furthermore, they advise having managers check often the market context for changes and verify their employees are ready to adapt and learn new abilities by rewarding the expected comportment.

In the very early stage of our business, reduced financial flexibility was one of the most critical challenges for the owners. The core business idea started as a project in a larger company, but, since this project was to be cancelled, they licensed the intellectual property and started a new company. They accepted the risk and

believed in the potential of the intellectual property. Part of the financing to run the business was personal funding; venture capital and synergies that were developed within their current network at the time allowed expansion over time. This effort provided a base level of financial flexibility that allowed hiring, building equipment and covering other costs.

Building credibility in the drilling business was also an enormous undertaking to find both customers and sponsors. Running tests to build credibility on rigs where daily operational costs are very high represented a significant constraint. Even more, proving the benefits and value of the system offered to the customers while learning about it simultaneously took many runs in the field and refinement by engineering.

The drilling operations typically run 24 hours a day, 365 days a year in remote and harsh locations. People that work in this sector must accept the nature of this industry and the sacrifices that accompany. For people not used to this environment, it can be challenging to become flexible enough to meet such demands. As a result, people retention can be problematic. Since the schedule, locations and work conditions change drastically, it was critical to have a great level of flexibility. In return, the industry has a reputation of rewarding this level of flexibility.

Simplified Organizational Structure and Growth

Jones et al. [9] claims that the simplified or lean organizational arrangement in small businesses compared to large companies presents benefits like direct communication and coordination among the managers. Regrettably though,

because of scarce management means and specialization, many functions are inadequately managed.

An example of this in our business is the situation in the equipment manufacturing and maintenance areas. A single person focuses in this area, and he is typically very busy building and refurbishing our hardware. The operations manager is appointed to run inventory control, purchasing, and shop management activities. Since his workload supervising the rest of the field operations and engineering is heavy, the tasks above are often neglected, or only critical tasks are engaged. Although the business is running fine, it is clear that the manufacturing and maintenance operations could be more effectively managed.

Eckhardt et al. [14]suggests that the lack of a formal organizational and information processing structure enhances the ability for small companies to achieve high growth by means of technology application. Less structure eases the reorganization and adaptation factors. Moreover, a reduced number of decision makers and employees give rise to an expedited decision-making process and quicker execution as a result.

In regards to the effects of a relatively informal and flexible organization on small business performance, I have directly witnessed the decision-making fluidity and the innovation culture being stimulated by this scheme in our business. The research and development activities are deeply interlinked and subordinated to field operations. Either remedial changes or new features are quickly developed and deployed in the field. As a result, operations are able to serve the customers on the rigs better. Such customers reward this adaptability with repeated or extended business

ORGANIZATION RESOURCES FACTORS

Number of Employees, Innovation and Market Value

Ceteris Inc. performed a study [16] in an attempt to establish the relationship between the number of employees in a small business and the innovation level as indicated by the number of patents generated. They found that as the number of employees increased, the number of patents increased as well. They realized that it takes time for the addition of new employees to show an effect in the number of patents generated. Based on the learning process, the actual developments and the patent granting process itself, they estimate that it could take up to five years to show in the statistics.

In the same study, Ceteris Inc. also attempts to correlate the innovation (number of patents) with the sales level. They could not obtain any meaningful correlation between these two variables, and they did not provide a definitive conclusion to the cause of it. Some examples of potential reasons are resource limitations or technical complexities that stretch the time-to-market of those inventions. It is known that patent contents might not be implemented on specific products or techniques in the market, but certainly represent roadblocks for competitors.

Ceteris Inc. was able to identify an increase of market value (price-to-book ratio) of small businesses as the expenditures on research and development increases. The study consistently shows an increase of market value per every one percent of expenditures in R&D. Such findings from the authors suggest that investing in people (hiring, training, retention, etc.) and research and development activities could positively affect the generation of intellectual property that, if

applied, could impact the marketability and differentiation of the company products and/or services offered.

In the case of our business, the addition of engineers has had a beneficial impact in unlocking intellectual property potential. The less experienced engineers still developing their skills and business acumen are directed towards continuous improvement activities or less critical research tasks. Even though such tasks are less critical, they are challenging and keep the motivation levels and learning pace as the engineers develop over time. The more senior engineers lead the less experienced engineers, and since they are relieved from less critical tasks, they concentrate on future developments that require more developed skills and business acumen.

Skilled Employees and Academia

From the human resources management perspective, Jones et al. [9] suggest that it would be beneficial for small businesses to hire people with advanced degrees or establish relationships with universities, especially when there are requirements to optimize the technological level of such businesses. They elucidate that it is common among business owners to be reluctant to hire highly qualified candidates mainly because of loyalty concerns given future professional aspirations of those people.

In our case, a Doctorate graduate with the right specialty has been hired as a strategy to develop more advanced tools to be incorporated into our control system. In addition, closer links with the drilling research center of the larger company we merged with have been established. The highest concentration of advanced academic degrees and research expertise has been made available to us. More

intensive cooperation has been exercised resulting in the generation of new protected intellectual property

Multidisciplinary Teams

It is very important for the success of startup businesses to build teams that combine different experiences and areas of expertise. Building a multidisciplinary team in our drilling automation business has been critical in order to address the different complexities of our system and be able to expand our business to a larger number of rig systems. Between seven engineers that make technical contributions, we have petroleum, electrical, mechanical and computer science specialties with different fields of expertise on top of those specialties. Also, different levels of degree advancement allows for solving complicated problems within the same discipline. Our system comprises electrical power and control, mechanical design for harsh locations, digital communication, and pneumatic and hydraulic interfacing with all the functionality implemented in software where advanced control techniques are needed in some applications.

Participative Management

Dale Compton in his book Engineering Management [7] argues that an element of success for enterprises is participative management. Participative management is the combination of employees' involvement and empowerment. They are expected to be contributors to the success of the enterprise and are encouraged to find the best ways to do certain tasks and reach an agreement among them and the management group. The management group establishes the goals or directives, but the employees are expected to come up with the solution. They are

given the responsibility and authority to make improvements with minimal supervision.

It is anticipated that in order to succeed, the enterprise must trust their employees. Compton's work is strongly oriented towards manufacturing. Nevertheless, the Participative Management concept is relevant to the small business setting given the resource limitations and the need to maximize their dynamics. Moreover, this could be a technique to maximize the utilization of human resources and also would contribute to the development of important technical and managerial skills of such resources. Compton contends that in the United States, top management frequently enforces a certain way to do things, and if results are not obtained, the employee suffers the consequences.

There should be a balance between trust and micro-management within small businesses. In the case of our business unit, there was a point were it was evident that an excellent level of performance was the result of very tight control on the activities of all the personnel. Higher expectations and faster results were the main motivators of such tight control. After the desired level of performance was achieved in different areas and the trust was built, supervision started to relax, and the focus was on the results, not the processes. With the addition of more people to the organization and complexities added, the supervision trust is still in place. However sometimes the expectations and trust become unclear, leading to frustration of supervisors and employees if a complete mismatch is uncovered after some time. The catch is that trusted employees assume that they are doing their best effort according to the objectives set by management. Frustration comes when there are negative consequences in spite of the best efforts and intentions.

Trust should transcend the professional level. In our business we have observed that people respond better to feedback and perform better when a true personal and professional trust is established. A key factor to establish such trust is constant communication and feedback. Show honesty and avoid possible unclear perceptions and assumptions within the workplace. Showing two different behaviors at the personal level and on the professional level and reducing the communication to a bare minimum creates mistrust. Some employees need more structure than others, even though they are trusted and confident. Reassurance and guidance is beneficial with them. As a consequence, participative management should be adapted to the employees' personalities and to the level of complexity. When middle managers are introduced to the structure, some balance between trust and supervision level should be established.

Professional Management

Because of the fast changing business conditions, Jones et al. [9] advocate that management must remain flexible and adaptable in thriving small companies, implying the adoption of entrepreneurial and professional management abilities is a necessity. Entrepreneurs commonly challenge the idea of external hiring or training for professional management since they support the incubation of managers from within based solely on experience specific to the business. The belief is that it is enough that incubated managers are expected to master the current processes and know-how of the firm.

Kathleen Allen [17] makes several interesting points about management during the rapid growth stage of the small business. She believes that high growth implies doing more of the same activities performed on previous phases of the

business. New complexities are added to the processes and new systems, controls and logistics are needed to sustain this new stage of growth. Such complexities demand additional skill sets that are not easily acquired during the high growth phase because there is barely enough time to meet demand.

She explains that it is not uncommon for entrepreneurs to have the belief that their skill sets are enough to address the challenges during high growth. Unfortunately, this is not true in most new ventures, in part because management will need to focus on different objectives at each phase. During the startup phase, management concerns will be about innovation, resource acquisition and survival. During high growth, its concerns will reorient towards efficiency, Allen explains

Unfortunately, as the level of complexity increases, there might not be enough skill to handle new emerging circumstances appropriately because those complexities have had no previous exposure. This is when expertise and/or training should bring in the abilities needed for the business to address the increased complexities.

Kathleen Allen [17] explains (quote):

> One of the most important tasks that entrepreneurs must undertake is building an effective founding team that includes the entrepreneur's key strategic partners, board of directors and advisors. The team should reflect the diversity of education, expertise and experience required to launch the new venture and take it through its early growth. Technology teams present unique challenges because often the founder has only technical expertise and therefore need to find partners with the appropriate business expertise to ensure that the new venture gets an optimal start. With limited resources, new ventures will typically need to outsource some of their requirements to independent contractors. Once the business begins to grow significantly, the entrepreneur will need to consider bringing on professional management to insure that systems and controls are in place and the company is prepared for rapid growth.

The author indicates that the attitude or preference of entrepreneurs has a tendency toward informality and flexibility and is more averse toward details and procedures. The opposite attitude could be exposed in professional managers coming from large and well-established companies. Nevertheless, Allen proposes that the real challenge for the entrepreneurs is to build a team that carries out the execution of the strategy instituted from their leadership role.

Regarding professional management referenced above by Allen [17], in our business some managers have been appointed from within in order to lead a group of specific tasks like engineering, field operations or regional sales. With the exception of field operations, the rest of the areas have not experienced intensive growth in number of people. However, the number of tasks and complexity has increased. As a result, the managers appointed are more focused on leading technical or sales activities. Their duties do not include human resources management tasks. The operations manager and business development manager have responsibility to manage human resource functions. Field operations have a field coordinator working as a middle manager between the field engineers and the operations manager. This coordinator has more involvement with human resources management due to the nature of his duties. In other words, professional managers are handling technical and sales complexities.

Intrapreneur or Change Agent

Jones et al. [9] highlight the importance of appointing a change agent or intrapreneur to take ownership of the change direction defined in the strategic framework. (Note that the intrapreneur definition utilized is a firm's internal entrepreneur). The change agent is expected to be a catalyst, solution giver, process

helper and resource linker. The business owner could assume this role, however they suggest delegating to a different person. One of the advantages of selecting an internal candidate for this role is familiarity with the processes, sources of power and norms within the system. Such agent should manage the creation and delivery of new knowledge across the firm (internally). Moreover, this agent should create and manage internal and external networks that are important to bring critical knowledge to remain competitive. In the case of our business, the operations manager has assumed the change agent role for all the activities related with engineering, manufacturing and field operations. The strategy gets defined between the operations manager and the business development manager.

CONCLUSION

In conclusion, relating the organizational structure factors above to our business, a combination of technology and production intensity applied to engineering and operations respectively has contributed to increased business. Financial flexibility was a critical challenge during the startup of our business, but up to a certain degree, a level of both financial and organizational flexibility has been achieved and has been advantageous. Having a flexible organization allows us to have a simplified structure with better communication and faster reaction to market demands in our business. Regarding resources, hiring new engineers with higher and varied degrees also has enhanced our innovation capabilities. Most of our people work with minimal supervision, and they are trusted to deliver excellent results. Such empowerment stimulates people in a positive ways and builds confidence in our people.

CHAPTER 5. COMPETITIVE ADVANTAGE CONCEPTUAL FRAMEWORK FOR SMALL BUSINESSES

One of the key elements to pursue growth is competitiveness. This chapter is intended to explore theories presented by different authors and relate to our drilling automation business. The expectation is to identify the elements that are making our business competitive and the ones that should be addressed to defend our market position. The models presented here will be helpful to perform an internal evaluation of our business at a higher level. Results will be summarized at the end of the chapter.

The following is a compilation of attempts to describe the competitive advantage factors of small and medium enterprises according to the literature analyzed by Jones et al [9]:

- "Firm competitiveness in competitive markets– Porter 1985"
- "Output Flexibility on industries with high fluctuations of demand and low profitability: – Fuegenbaum and Karmani 1995"
- "Competitiveness factors: quality diversity and cost Lefebvre and Lefebre, 1993"
- " …is a function of a firm's industry mastery, cost superiority and broader political and economical environment. -Oral, 1986"
- "Independence -Jennings and Beaver, 1997"
- "Management processes in small firms bear little or no resemblance to management processes found in larger firms - Jenning and Beaver, 1997"
- "Organization Structures are likely to be organic and loosely structured rather than mechanistic and highly formalized" (Jenning and Beaver, 1997)

From the research of Jones et al. [9], fellow authors propose an abundance of hypotheses about the inputs and contexts on small businesses that have an effect on their competitiveness, success and growth. However, there is no strong consistency or repeatability of the elements that influence overall success. They argue that there is evidence that there is actually a complicated a mix of interacting elements that might increase or diminish the likelihood for small businesses to succeed. Moreover, multiple types of management functions increase the difficulty of having a condensed set of suggestions. Following, we present two models related to competitiveness.

COMPETENCE AND COMPETITIVENESS

Man and Chan [18] identified six competence and competitiveness areas as Jones et al. extracted from their work in Table 3. Each competency area is supported by specific sets of behaviors. It is important to note that one competency area could apply across multiple functional areas of the business and vice versa. For instance, the relationship, conceptual and organizational competencies are strongly linked to a research and development department.

Competency Area	Behavioral Focus
Opportunity competencies	Recognize and develop market opportunities
Relationships competencies	Person-to-person, group-to-group interactions based on cooperation, communication and trust
Conceptual competencies	Conceptual abilities related to decision-skills, information absorption, risk-taking and innovativeness.
Organizational competencies	External and internal activities associated with human, physical, financial and technological resources
Strategic Competencies	Setting, evaluating and implementing strategy
Commitment competencies	Entrepreneurial drive to develop the business

Table 3. Competence and competitiveness (Man and Chan 2002) [18]

In Table 3, there are a couple points that relate to the other authors researched. First, there are the organizational capabilities that are intimately linked to the structural flexibility referred to the work of Verdu et al.[15]. Being a flexible organization goes beyond the ability to change the organizational structure. Such changes have to be truly meaningful to the business objectives, and all the potential consequences should be evaluated beforehand and then implemented if feasible. Such modifications require the right skills to implement properly. Second, regarding the strategic competencies, we can relate to the Lean Startup concept of Eric Ries [19]. He argues that the strategy is an item that is susceptible to change depending on the learning milestones obtained from product changes. Since the strategy determines the boundaries and directives that product development should follow, it is very important to have the right skills to be able to architect and modify the business strategy.

For our business, the extensive experience in the drilling field and skills of the management team has proven to be essential for the strategy development in the last 10 plus years of the small business. Growth and results substantiate the skills. Table 4 below presents a brief analysis of the behavioral focus of our drilling automation business following Man and Chan's competence and competitiveness areas from Table 3. Performing the analysis provides a competency overview of the company that could be used to define the strategy and help to uncover areas of opportunity. One opportunity area uncovered for our business is internal team and relationship building.

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Competency Area	Behavioral Focus (Drilling Automation Business)
Opportunity competencies	Recognize and develop market opportunities: • Constant monitoring of drilling activity and competition in the country and abroad. • Understanding technology and application trends • Understanding customer needs of drilling
Relationships competencies	Person-to-person, group-to-group interactions based on cooperation, communication and trust: • Continuous development of partnerships and synergies with third parties in order to improve our technologies and to generate mutual business opportunities. • **Internal team building and communication across departments could be improved**
Conceptual competencies	Conceptual abilities related to decision-skills, information absorption, risk-taking and innovativeness: • The decision-making process is short, and the outcomes are bold decisions. This is driven partially because of the expertise level achieved so far and partially because there is a strong entrepreneurial approach with no aversion to calculated risks. • There is constant exploration of new ideas about how to maximize the technical abilities of the engineering team and how to create new tools and features for the customers. • Intellectual property protection is continuous.

Table 4. Competence and competitiveness overview for small business on drilling automation

(Table 4 continued on next page)

Competency Area	Behavioral Focus (Drilling Automation Business)
Organizational competencies	External and internal activities associated with human, physical, financial and technological resources: • Activities related with human, physical and financial resources have been improved by the adoption of systems from the larger company of the merger. • Local administration team has been expanded and trained to maximize efficiency of the administrative transactions using custom and inherited management systems. • Technological and operational activities still remain mostly independent. There is high level of specialization and tight control in the business unit. Activities are not closely matched with those of the larger company.
Strategic Competencies	Setting, evaluating and implementing strategy • **The evaluation of the strategy implemented is informal. However, important revisions and direction changes are derived from it. A more explicit review exercise could unveil opportunity areas to address.**
Commitment competencies	Entrepreneurial drive to develop the business • The original management team members that started the company or joined early still continue in their roles today. As the company grows in number of employees, a significant sense of commitment and responsibility to them and to each other is shared among these members in spite of strong disagreements.

Table 4, cont. Competence and competitiveness overview for small business on drilling automation

Since the company has merged with a larger business, there are policies and systems that our business unit has inherited. Nevertheless, the strategy, engineering, operations and marketing remain mostly intact after the merger, and such activities still determine the success of the business unit, just as with an independent small business.

COMPETITIVENESS MODEL

Diving deeper into Man and Chan's [18] work, they propose the Small and Medium Enterprise Competitiveness model shown in Figure 1. It intends to describe the actions performed by the entrepreneurs when seeking performance within their firms. The model comprises four main dimensions for competitiveness: external potential, internal potential, process and performance. Note that the process dimension refers to the current competitive areas, as described in Table 3, that drive the actual performance of the firm.

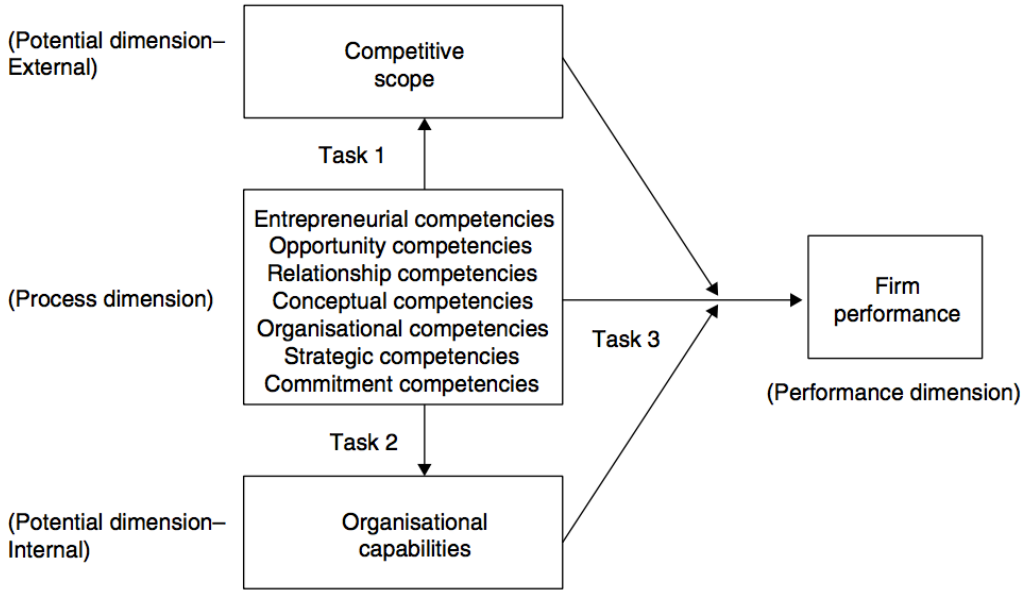

Figure 1. Competitiveness of the Small and Medium Enterprises (Man and Chan 2002) [18]

Evaluating the internal and external factors will make it possible to match the abilities to the strategies. Table 5 details the 'tasks' depicted in Figure 1 that the entrepreneur should execute across the different dimensions. This model is similar to the concept of flexibility alignment by Verdu et al. [12] explained earlier. Note

that Task 3 is where goals for the firm are set, and internal and external potentials are linked.

Task 1:
Process to Potential (External) Dimensions
	• Observe the context outside the firm:
	  ○ Market heterogeneity
	  ○ Market attractiveness
	  ○ Product/industry life cycle
	  ○ Market demand
	  ○ Competitive concentration

Task 2:
Process to Potential (Internal) Dimensions
	• Concentrate on internal capabilities:
	  ○ Innovation
	  ○ Quality
	  ○ Cost effectiveness
	  ○ Organicity

Task 3: **Potential/Process Dimension to Performance Dimensions**	• Set goals for firm performance • Link exterior context and internal competencies

Table 5. Dimension linking tasks for competitiveness of the Small and Medium Enterprises (Man and Chan 2002) [18]

Table 6 displays examples of the dimension linking tasks for our drilling automation business based on Table 5. Note the outcome of task 3 for our business. External and internal dimensions were linked, and actionable items were the result. Actionable items were identified for different functional areas including research and development, legal, marketing and human resources. Linking is a powerful tool to generate action items from a very comprehensive look of the whole business.

Task 1: Process to Potential (External) Dimensions	Observe the context outside the firm: • Market heterogeneity ○ Customers have been exposed to different automation systems leading to different preferences. ○ Different ground formations present different levels of challenge for drilling. Our system holds more value when challenges are higher. ○ There is ability to interface with more drilling rig types available on the market. • Market attractiveness ○ Low budget rig operations typically have problematic equipment to interface with and operators want to get the service at a much lower price, reducing the attractiveness. ○ Higher budget rig operations typically have state of the art equipment and can afford more advanced technologies to address the same problem we do with our system. Only when such advanced technologies are more risky to use at the specific well do we have an opportunity to maximize price. ○ Other opportunities are evaluated on a per case basis, and special agreements are possible. • Product/industry life cycle ○ The value that our system delivers has been extensively proven in the field and competitors have arisen. The system is on the verge of becoming a commodity. As a consequence, engineering is working on more sophisticated and comprehensive solutions. • Market demand ○ Demand is dependent on oil and gas prices. The higher the price, more challenging wells are drilled. Such wells are a good application for our system. • Competitive concentration o Competitors exist whenever a directional drilling operation is run

Table 6. Dimension linking tasks for competitiveness for the Small Business on Drilling Automation

(Table 6 continued on next page)

Task 2: Process to Potential (Internal) Dimensions	Concentrate on internal capabilities: • Innovation ○ More engineers with advanced skills have been added. ○ Engineers are trained on required topics. ○ Networking with other specialized engineers to unveil new development opportunities is a practice. • Quality ○ Engineers with higher seniority lead critical developments and supervise routine developments. ○ Equipment is certified for hazardous locations ○ There is standardization of equipment and manufacturing methods. • Cost effectiveness ○ Standardization allows volume agreements for components and ability for troubleshooting by all field engineers rather that specialized people. ○ Reduced number of engineers and less bureaucracy allows focus on important and critical tasks. There is the perception of more being achieved by less people. • Organicity ○ A smaller team allows for quick reassignment of tasks according to the development strategy changing continuously.
Task 3: Potential/Process Dimension to Performance Dimensions	• **Set goals for firm performance** ○ **There is liaison with other drilling contractors.** ○ **More advanced and comprehensive drilling solutions are developed.** ○ **Marketing efforts are joined with larger company post merger.** ○ **Intellectual property is aggressively protected.** • **Link exterior context and internal competencies** ○ **Advanced skills engineers were hired.** ○ **Links with drilling research center of larger company (merger) were established.** ○ **Field engineers with higher academic degrees have been added and provided more extensive training.**

Table 6, cont. Dimension linking tasks for competitiveness for the Small Business on Drilling Automation

Completing Table 6 for our business was useful to verify the alignment of our internal competencies with the external context. The misalignments show opportunities for market strategy changes and internal modifications to the organization in order to achieve a higher level of performance. I suggest performing the dimension-linking task at different stages of the business on a regular basis as opposed to a single time evaluation. The above was a high level analysis could be even more beneficial if a deeper dive was taken. The most important outcome will be the action items to pursue after the analysis. There are areas of opportunity that could be identified at a higher level that are likely to be ignored otherwise.

PLANNING VS. THE PLAN

Marsden and Forbes [9] further found that there is not a clear pattern of the effects of formal planning on the competitive advantage of small businesses. However, they highlight the conclusion from other authors that small businesses benefit from the mere action of planning rather than a formal process or a formal plan. They argue that over the years, the complexity and fast changing environments have driven big firms to adopt more flexible planning schemes and perhaps even reduce the energy spent on such process.

In our unit, most of the short-term planning and reviews of objectives and activities are discussed in weekly meetings, and from there it drives modifications of the short-term plan discussed in previous meetings. The benefit of a more informal short-term plan is the flexibility to correct on short notice the course based on the progress and strategies defined, given the dynamic operations of the company. Such informality of planning would not be beneficial but rather be detrimental if frequent meetings did not occur. Long term planning should originate from a detailed

analysis of the internal and external contexts and the strategy. In the previous chapters, we explored models that could be helpful in such analysis. It is recommended that formal long-term plan be established and short term planning should serve to meet the objectives of the formal plan. This is critical to implement measures that lead to enhanced competitiveness.

CHAPTER 6. DEVELOPMENT OF TECHNOLOGY PRODUCTS

INNOVATION PROCESS FRAMEWORK

Similar to the Competitiveness Model by Man and Chan in Figure 1, Atherton and Hannon [10] developed an Innovation Process framework for small businesses shown in Figure 2. The framework includes the scanning of the external environment and evaluation of internal capabilities with matching to the opportunities found. Note how the strategy and innovation bound these activities along the process. Such framework is valuable in providing a high level overview of the activities of the innovation process. Jones et al [9]emphasize that rather than concentrating on major or perhaps disruptive break through advancements, small businesses could benefit more from small innovative improvements

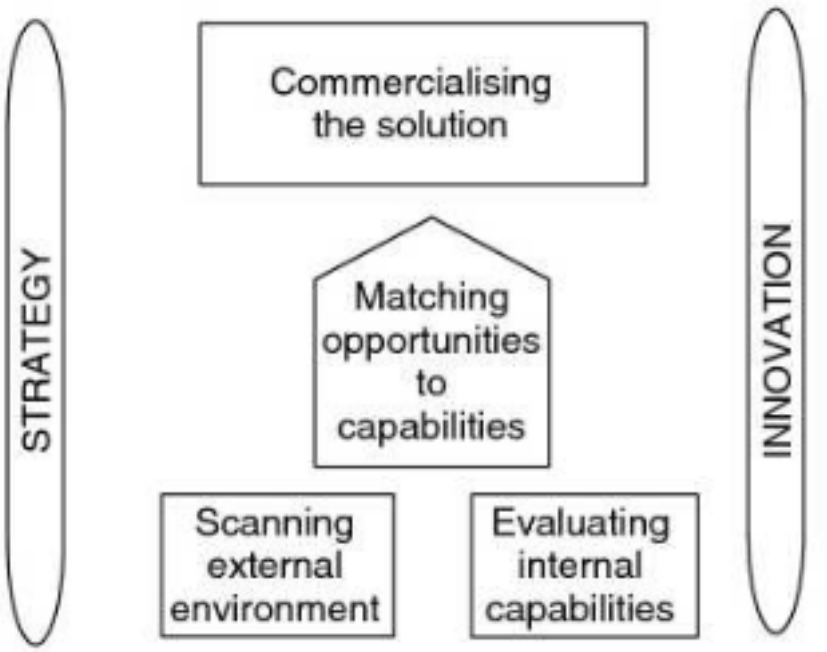

Figure 2. The Innovation process in Small Businesses (Atherton and Hannon, 2001) [10]

Innovation in our drilling automation business is still the core of the success of the firm. There is an unceasing drive to provide the most advanced solution, and the capabilities developed go along with the intensity of innovation desired. The software of our business has followed this development approach. Since the business model is equipment rentals, we manage all the systems deployed in the field. This makes it easier to deploy software updates more often with minimal disruptions in the field rather than major upgrades. We continuously improve the control techniques and add new features that have an impact on the value and quality of the service we provide.

R&D OUTSOURCE

With respect to research and development for technology products, Kathleen Allen [17] suggests the use of independent contractors with the appropriate specialization and expertise to carry out specific tasks as a transactional development rather than immediately hiring employees and commit to long term expenses. The disadvantages are that those contractors follow their own methodology to meet the results of the developments agreed. Also, hidden costs are implied from following this path, such as time and resources spent to select the right outsource, to get such outsources acquainted with the company, to manage the relationship and later to bring their assignments in-house. Allen [17] concludes even though contracting has its benefits, entrepreneurs prefer to do more strategic tasks in-house rather than outsource.

Another interesting argument by Allen [17] is that in order to sustain a fast pace of innovation necessary to take chances in a competitive market, companies rely on having their own teams with the right expertise and experience, not to mention other resources like specialized equipment or expensive software. Regrettably, it is not possible for all the companies to readily have access to all the resources needed without investing a significant amount of resources that could be used on other areas. For this reason, the author advises outsourcing technological development activities as a way to access to the right talent, experience and resources at an acceptable expense (cost reduction). This also lowers the risks and reduces development time by 60-90 percent per Allen‘s research.

Development outsourcing with a system integrator was the initial approach for our drilling automation business. At startup, the owners of the company, whose specialty was centered on the petroleum area, did not have the expertise in control

systems, software development or electrical engineering. Since they could not commit financially to recruiting people to design and integrate the system, they hired a systems integration company to develop the first drilling automation system for the business. Once they gained market momentum and the system started to become more complex, it eventually became more expensive to pay for consulting development. They then brought the development in house by hiring a software engineer to work on the pre-established platform. Another motivator of this change was intellectual property protection concerns. They could not control which development engineers from the systems integration company would be assigned to their project and whether such company would be able to retain their people and prevent from being recruited by competitors.

EXTERNAL NETWORKING

The authors consider external networking to be essential given the limitations of the small businesses to internally generate all the knowledge needed to survive. Kathleen Allen [17] advises bringing in information pertaining to the development from external sources through networking. She mentions that some organizations have the paradigm that if certain inventions are not done internally, then there is no value in them. This concept creates reluctance to create synergies with other technological organizations. As a consequence, there is slower time to market, difficulties in understanding or anticipating the needs of the customers and even inability to take basic technologies to the market because of lack of processes to do so.

As mentioned earlier, a more active interaction of our business unit with the research center of the larger company of the merger has helped to generate new knowledge to address new engineering developments and intellectual property.

INTERNAL NETWORKING AND KNOWLEDGE CONVERSION

Internal networking relies on the conversion of tacit knowledge to explicit knowledge and then ensuring access to such information by everyone who needs it. Regarding giving higher priority to tacit knowledge compared to formal intellectual protection, in our company, there are several patents that protect the main core of our technology. Alternately, a significant number of features are rather kept as trade secrets. The main reason for trade secrets vs. patents is the often-unreasonable amount of resources to formalize intellectual property protection. Only very critical and fundamental inventions that will be disclosed are going thru the patenting process. This is also viewed internally as a strategy to maintain the high fluidity of our activities for reaching the technological implementations faster.

In regards to administrative documentation on our business, the number of electronic forms and databases has been increased as a way to trace activities and money and also for exchanging information with the large company post merger. A mobile application has been developed for field engineers in order to document activities, track equipment and search field information in real time. Early on, everything relied on phone calls across coordinators and engineers but not anymore.

PRODUCT DEVELOPMENT PROCESS MODEL

In Figure 3 on the next page, Allen presents a development process model for new technology products. The model describes the process from the invention stage to the market launch. Through the process she describes six "roadblocks and speed bumps" (detailed in Table 7) that could decelerate or alter the course of the development process. She explains that it would be very important to bring business expertise with better understanding of the market rather than having "theoretical" assumptions often made by technical people in order to get past those bumps and roadblocks. By doing so, the chances of success in the market increase.

Note the multiple feedback loops. This implies that the process does not flow linearly in time. Returning to preceding stages is expected along the journey. There are four feedback loops returning to the very first stage, invention or discovery. One of the loops returns all the way from the last stage, market launch. This leads to the belief that the process is cyclical, either for consecutive developments of different products or improvements to a same product (spiral).

In our business such product development process is applicable to each new automation product that we develop. However, the roadblocks and speed bumps might differ from the original model since we have not been in the startup phase for close to a decade

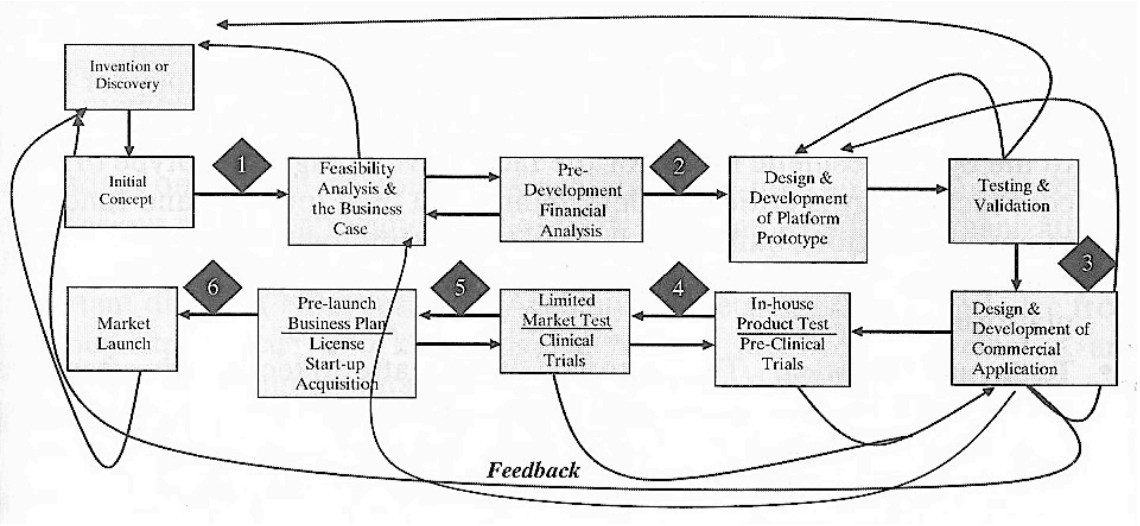

Figure 3. New technology product development process (Allen 2010) [17]

Roadblocks and Speed Bumps	
1. Fear of the unknown. Is there something novel and patentable?	2. What is the level of demand and the adoption pattern?
3. No market knowledge. Is there a customer and a compelling need?	4. Launch Strategy. License? Start a company? Be acquired?
5. Funding for prototyping. Finding the right applications.	6. Difficulty of moving from laboratory to company.

Table 7. Roadblocks and speed bumps on the new technology product development process (Allen 2010) [17]

Table 8 below presents a sample analysis of the roadblocks and speed bumps based on Allen's model in Table 7 that the entrepreneurs faced at the startup of the drilling automation company. The value of this analysis and the model is the identification of critical points during the development of future technological

products so preparedness can be implemented. Identifying roadblocks and speed bumps from previous processes can be used as lessons learned and resolutions for future developments.

Roadblocks and Speed Bumps for Small Business on Drilling Automation	
1. Fear of the unknown. Is there something novel and patentable?	At the time, there was exploration by different companies to automate the whole drilling process. That task is extremely large and intricate. They decided to break apart the process and address the automation piece by piece. New ideas were generated and patented from than analysis.
2. What is the level of demand and the adoption pattern.	The number of rigs that were drilling challenging wells kept increasing at the time. If future test results demonstrate the benefits and usability of the automated system, the potential for business would be significant.
3. No market knowledge. Is there a customer and a compelling need?	Drilling operators manually performed the operation that the automatic system would assume, establishing the need for such operation. Inconsistency and repetitiveness of such operation being done manually would justify an accurate and automated solution.
4. Launch Strategy. License? Start a company? Be acquired?	The company owning the intellectual property decides to shut down the drilling automation project. Two of the key people working on this decided to start a new company, licensing the intellectual property (later acquired) and bringing test equipment with them to the startup.
5. Funding for prototyping. Funding the right applications.	A lot of work was done to establish credibility of the project. Funding was received, and special agreements for testing were arranged as a result of networking with other businesses.
6. Difficulty of moving from laboratory to company.	An agreement was reached with the origination company to use one of their facilities to start the company. The business was established as a Limited Liability Company, and other legal requirements were covered.

Table 8. Roadblocks and speed bumps on the new technology product development process for small business on drilling automation

THE LEAN STARTUP MODEL

Eric Ries [19], in his book titled the Lean Startup, introduces a new way to apply concepts from lean manufacturing into innovation within startup businesses called "The Lean Startup". From the lean manufacturing philosophy implemented in the Toyota Production System, Ries adopts the concept of "genchi gembutsu" or "go see for yourself" where people are encouraged to gain product and quality understanding directly from first hand observation rather than relying on secondary routes. As the author claims, Lean Startup is a philosophy rather than a collection of tactics.

Customer Feedback

Part of the knowledge procured on this concept is customer needs and how to deliver better quality. One way to obtain this data is by asking customers directly. However, Ries argues that such feedback could be taken as another source of information about the product along with the overall vision. Taking such feedback as the only and definitive source of information to make decisions on the product could mislead the strategy. Ries explains that there are two potential dangers. On one hand, once the customer feedback has been obtained, a very detailed plan to meet the customer needs could be implemented and executed with a successful ending. However, if it is not what the customer needed in reality (perhaps unintended), it is likely that such plan will lead the entrepreneurs to a dead end after spending significant time and monetary resources. On the other hand, if plans are refined excessively, it can cause "analysis paralysis" where there is ultimately a failure to act in a timely manner or at all.

Build-Measure-Learn Loop

What Ries proposes, in order to avoid the dangers mentioned above, is to create a baseline hypothesis or hypotheses about what the customers want or what represents value added to them. Then build a basic product that would test the baseline hypotheses proposed either in a bundle or separate trials. The test should involve exposure of the basic built samples to real customers and collection of product and customer feedback that is translated into new learning. Such learning will serve as the main guide to refine the basic product again for subsequent tests over and over again. The author mentions that the early adopters are good candidates to test new products as such adopters are more forgiving and willing to provide useful feedback. Ries calls this iteration process the "Build-Measure-Learn Loop", shown on Figure 4 below.

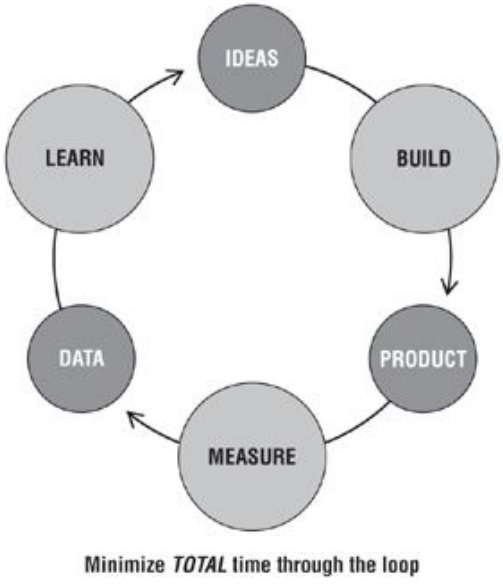

Figure 4. The Build-Measure-Learn Loop (Ries 2011) [19]

With respect to the Build-Measure-Learn loop, Ries describes three core deliverables resulting from the main loop activities. The data measured from the product test and ideas resulting from the learning process are key elements to the innovation accounting concept introduced by the author. The innovation accounting's main objective is to ensure that all the efforts made along the development process are truly targeted to either add value to the customers or enable growth along the innovation process. Any effort, resource or feature that does not contribute to both targets should be considered a waste and, as a consequence, be eliminated in the next loop iteration. Applied learning is the key for success, and this should be kept in sight at all times. Ries explains that the main elements to account are Learning Milestones that are regarded as more valuable than budgets and timelines. Moreover, when customers validate knowledge that is acquired thru the cyclic process, the overall innovation process becomes more concrete, accurate and faster than having a traditional planning implementation according to the author.

Minimum-Viable-Product

In relation to building a product, Ries explains that it is not uncommon for the entrepreneurs to be reluctant to present an unfinished, buggy, feature limited product in front of customers. Regrettably, delaying the exposure and test of such product could be costly as more resources are spent and learning is not obtained fast enough. Ries proposes building a “Minimum-Viable-Product” that will present fundamental value hypotheses in front of the customers allowing the collection of data sooner. In building the Minimum-Viable-Product, entrepreneurs should resist

the temptation to either overbuild or overpromise and rather focus on the hypotheses testing tasks, refraining from wasting resources.

The entrepreneurial spirit endorses taking risks and "quick failures" as long as learning is achieved. The faster launches happen, the sooner learning becomes available, enhancing the value addition process.

Change Strategy on Lean Startups

From the literature, it has been established that innovation is rather a continuous process. Joining the ideas about the Build-Measure-Learn Loop with the innovation continuum idea, an ascending spiral could be conceptualized on which the innovation accounting is the central axis upwards.

At a higher level, Eric Ries models two intensities of change shown on Figure 5.

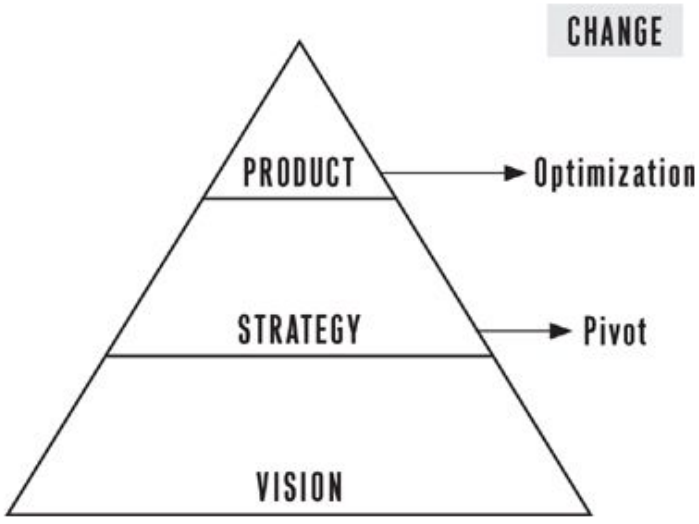

Figure 5. Change for a startup at different levels (Ries 2011) [19]

On top of the pyramid is the product, which is cyclically optimized or tuned via the Build-Measure-Learn Loop as discussed earlier. Such product is developed based on the strategy. Such strategy is only necessary to change or pivot whenever a critical and aggressive change is necessary to create value. At the bottom of the pyramid is the vision, which defines the startup business objectives. It should be understood that strategy is anchored to the vision. It would be truly exceptional that such vision would need to be modified. As a matter of fact, during the strategy and product definitions, is expected to intrinsically maintain the vision at all times.

Lean Startup Model Scalability

An interesting aspect of the lean startup model is that it should not be exclusive to startups or small businesses, according to Ries, but scalable to companies of any size that are looking to become a "disruptive innovation factory" at different orders of magnitude. This perhaps could be true within innovation incubators within a large setting, in other words an intrapreneurial environment.

In regards to the Build-Measure-Learn loop described by Eric Ries, we have observed the benefits of an increased loop rate in our business. Software is one of the core components of the system we deploy on the drilling rigs. One of the strategies established by the operations/engineering manager is to minimize the time that it takes to implement and deploy new features and fixes on the systems at the rigs, thus maximizing the exposure to real end users at multiple rig configurations and drilling conditions. This exposure has allowed a quick and effective learning process that has helped us to determine what features should be kept and enhanced and what features should be eliminated completely. In other words, it represents the innovation accounting for our engineering team.

In order to achieve a higher innovation rate, features with minimal functionality are deployed based on observations and estimations. Calculated risks are assumed. For our teams, this represents the Minimum-Viable-Product described by Ries.

DEVELOPMENT RISK FACTORS

In her work, Allen identifies two main factors as the strongest contributors to the failure of new technologies. The first factor is the limitation of assets, which leads to the creation of products that fall short on functionality or quality due to the avoidance of costly research. Sometimes a premature ending of the development cycle occurs that obligates the entrepreneur to go back to earlier stages of the development process and rework multiple times. As a result of this, time is wasted, and opportunities to be first-to-market are lost.

For our company, before the startup stage, the technology in question was a research project within a larger company that employed the current owners. The larger company invested significant resources in the project research before the entrepreneurs decided to start a new business. After separation, networking to obtain more resources helped to continue with the research and to build the first Minimum-Viable-Product. Establishing credibility and marketability for the project was a significant challenge that ended with the reward of a successful business.

The second cause of failed technologies is the lack of market research. Without basic research on the customer needs, competition, etc., the technology will be unlikely to meet customer needs or to position the product in the market successfully no matter how advanced or innovative the technology is. Allen asserts that arrogance or overconfidence by the entrepreneurs in their inventions leads

them to ignore the market research task. From Eric Ries's [19] work mentioned earlier, care must be exercised when doing market research, especially when customers are asked directly about their needs. The context needs to be taken into account first in order to put customer's feedback into perspective so a more accurate decision on investments is made.

One of the key functions of project management is to ensure success. As a consequence, risk management during the project execution is expected in anticipation of difficulties during the development of the product, manufacturing and launch. Extensive planning, documentation and analysis of internal and external factors help to reduce the anticipated risk. Allen debates that if entrepreneurs are too risk averse, they will fall short of taking chances that are crucial for the success and expansion of the company.

According to Kathleen Allen [17], a third risk factor is the technology itself. She explains that the profitability derived from the technology is affected by the intricacy of the technology itself and obsolescence. Resources are needed to manage these factors, and it is likely to jeopardize entire projects if not handled appropriately. Allen proposes several options to manage technology risks:

1. Utilize field or market tested components whenever achievable.
2. Remain open to multiple solutions rather than pushing a single one. The reason given by Allen for this is that the expense of delivering one erroneous solution could be greater than providing multiple ones.
3. Seek feedback from the end users during the development stages. Such information could be very helpful in delivering the right solutions by applying the right resources to the right place before market release.

4. Address the riskier developments as first priority. As mentioned earlier, quick failures are encouraged in healthy innovative environments. Knowledge earned from such failures could be used to mitigate future risks and could save resources by avoiding research reiterations.

Relating to the options that Allen proposes above, we have the following solutions in order to manage technology risks in our business:

1. Most of the components utilized in our system are off the shelf, short lead-time items. Some specialty items that the vendors do not stock are purchased in advance and we stock a minimum reserve. Most of the hardware has been tested in oilfield control applications.
2. On occasion, some issues are observed in the field where our software is utilized. Such issues are sometimes related to either the type or maintenance of the equipment that we are controlling rather than our system itself. In order to mitigate these problems (unless is a major fault state), we implement several features that allow control of the rig equipment in spite of those issues. When our software is the problem, we always have a rollback version with the last good known state, and then we fix the issues in the latest versions.
3. The feedback from the operators of our system is critical to our success. Unfortunately, such operators are often not qualified to accurately describe the features they would like to see or to explain issues they have with our software, even when they do an excellent job utilizing it. That feedback is typically collected on a daily basis by our field engineers who are better qualified, but not in a technical depth to always suggest the best solution.

They interpret such information and then communicate to engineering with the two layers of distortion described. Before implementing a new feature or making a fix that has been requested from the field, we arrange discussions with the most senior people from the field and engineering, and after analyzing the context of the problem described, a decision is made on the nature of changes and whether to implement them.

When either a software or hardware problem arises at our end, disrupting the operation of a rig and potentially affecting others, the normal priority projects are put on hold, and a search for a resolution is triggered. Depending on the severity of the issue and its complexity, a temporary fix could be deployed in matter of hours, and when the field situation is resolved, the fixes are then implemented as part of the official next revision of software

SUMMARY

Focusing on innovation, review of strategy and external context is important to keep the development process moving in the right direction. Internal limitations could be a constraint and should be taken in consideration. Getting assistance from outside the business is encouraged, especially when there are limitations on resources and expertise. Facilitating internal communication is critical, and the conversion of knowledge from tacit to explicit is key. The roadblock and speed bump analysis for the New Product Development Process was useful to identify the key constrains from the market perspective that our business went thru. Business expertise during that stage of the startup was very important to overcome such constrains. The development model could be applied continuously for new products within the same business. The Lean Startup model is helpful in validating

product characteristics from real and continuous customer feedback during the development process. Constant ratification of the direction intended is possible by changing the vision or even the strategy when necessary. Allocating resources and doing market research help to minimize the risk of running out of development resources or wasting them. Technology risks like complexity and obsolescence should be taken into account for any new development. Careful analysis should be performed in order to devise the best strategy to minimize such risk.

CHAPTER 7. CONCLUSIONS

Even with scarcity of specialized literature and theoretical models focused on the small business setting and lack of conclusive elements on the interactions or all factors affecting small businesses performance, there is valuable information available that pertains to our company's survival and continued growth. By scrutinizing the existing data and models from literature and evaluating the applicability to small business based on the cost-benefit criteria, I identified useful and actionable information.

The theoretical research conducted and linking of findings to observations within the specific business I work for helped to propose answers to those questions. As one of the authors reflected, there is a very complicated interaction of factors that determine the success or failure of small businesses, and the expectation of a very bold and definitive answer to each question is unrealistic. However, given the success of our business, the observations and the proposed theories from the research, there are relationships and similarities to models that provide much better understanding of the factors that could have driven the success of the firm and also identify weaknesses that may be corrected.

Below condensed answers for the thesis questions are presented

1. **What are the likely factors that helped the company to survive startup and take off?**

During the startup stage of the company, there was a high level of uncertainty about income, and a high level of expertise in the automation field was required to develop the application from the beginning. The owner would not be able to commit to hire somebody with such expertise. Outsourcing the development

was the key to get the right expertise through a transaction-based agreement that could be managed without formal long-term commitments. Since the development was of high strategic value, they hired staff with the right expertise once the business achieved the needed credibility and future projections to support long-term employment commitments.

During the product development process of the automation system, they were able to overcome the roadblocks and speed bumps that they faced. Among the drivers that broke the roadblocks were the generation of intellectual property, deep knowledge of the potential market, financial flexibility obtained from capital and other resources by means of the relationships established. These all played a critical role for the survival of the business at startup.

2. **What are the factors that influenced a sustained growth stage and ensured the business stays competitiveness?**

The level of competitiveness of the firm had to do with the level of competence from the expertise that the owners brought from previous exposure. That competence was translated into the right behavioral focus for the different areas of leadership of the business such as the recognition of opportunities, development of relationships that derived successful cooperation with other parties, administrative improvement, and a strong entrepreneurial drive.

The competencies should be continuously evaluated against the external and internal potential dimensions so they are modified accordingly.

3. **How does the small business sustain innovation in the long run, even when it becomes a larger organization?**

Innovation should be a core principle and value for technology companies, and the appropriate environment and culture to support it should be implemented.

Whenever innovation is intended in small businesses, small improvements are legitimate and valuable sources of innovation in the long term.

The Product Development Process model applied to the startup of a new technology business described several roadblocks and speed bumps that could be faced in different steps of such process. The roadblocks concept should not only apply to startups but also to any new development in established companies. Applying lessons learned from earlier projects, will make it easier to overcome roadblocks that are likely to be faced in the future.

Creating multidisciplinary teams and hiring advanced degrees enhanced the technological capability of the business I work for and, as a result, the innovation potential. The increase in the number of protected intellectual property correlated with the increased number of hires for research and development supports the addition of skilled people to the firm. This is the path that the company I worked for pursued.

The application of certain aspects of the Lean Startup model to the business like the Build-Measure-Learn Loop has led to a faster rate of innovation by encouraging exposure of Minimum-Viable-Products to real customers and collecting essential data for the learning process. Such learning process should be traceable using the innovation accounting concept where value delivered to customers is the main objective. The Build-Measure-Learn Loop, as a concept, could be scaled to larger products, preserving innovation accounting as key metric. As a result, a higher pace of innovations should be possible as the company grows along with its complexities.

Depending on the intrinsic complexities of technology applied to projects, there will be risks. In order to sustain innovation in the long run, it is necessary to

handle such risk by finding multiple solution possibilities for the same problem when it is appropriate, using market tested components whenever possible, prioritizing higher risk projects at the top and carefully gathering customer feedback.

4. **Is the informality practiced with various processes within the company appropriate?**

The level of informality tolerated within the firm should be related to the level of performance. Any formality level introduced to the firm should be supported by clear benefit expectations, and the cost of implementing such formalities should be reasonable in relation to the benefits.

For instance, several engineering or administrative processes generate knowledge that might need to be communicated or protected. When a process or product is requires repeatability, a higher level of formality is recommended, and conversion from tacit to explicit knowledge is recommended. Documentation is an example of knowledge conversion. There are standards available in the industry that could help in the documentation process baseline. Custom methodologies are encouraged if they provide value.

In regards to the strategy, it has been developed taking into account the extensive experience from the management body in the applications specialty. There may be benefit to a more formal evaluation, uncovering relationships and details not anticipated that could lead to different decisions. As the company grows, a more formal evaluation of the internal competencies might also be beneficial.

5. **Is having a flexible organization in the small business beneficial for its performance?**

From the research presented earlier, there are different types of flexibility: financial, structural, operative and strategic. Depending on the industry that is being served, different levels of flexibility intensity and types are rewarded. The key learning is that it is necessary to align such flexibility with the needs of the industry. Financial flexibility is the one that small businesses struggle with most frequently, especially at the beginning. The need for capital from investors or other sources plays a critical role that could determine the survival of the business. Part of the challenge to get capital is to establish credibility. This was the exact route that the company I work for took. Larger businesses might be conceived as having a higher level of organizational, structural and operative rigidity, but they will typically have higher financial flexibility that creates disadvantages for small businesses.

Higher flexibility of any type will generate higher costs. As a result, unless it is rewarded by the industry, there should be moderation in the level of flexibility adopted in the business. The ideal level of flexibility could be graphically described as the intersection of cost vs. benefit.

6. **In which growth stage is the introduction of formal and trained management required?**

Professional management becomes more of a necessity when a higher level of complexity is introduced to the firm with growth. Depending on the business and growth rate, a higher level of complexity will occur in different stages of the business. One of the key indicators for making a decision to introduce professional management is when entrepreneurs are getting distracted with too many operational issues rather than making sure that the strategy is adequate and that it has been implemented or alternately when focusing on the strategy results in the tactical items being neglected. Now would be an opportune time for our company to

consider the addition of professional management to address areas such as shop management, inventory management, fleet management, etc.

Preparing people with professional management skills from within the company has the advantage of know-how and culture being carried on. Hiring professional managers is appropriate when their skills and expertise are highly valued and the know-how could be learned over time. Within the company I work for regarding the consideration of adding management, the pros and cons of each should be evaluated prior to committing to the approach.

Note, the above conclusions are relative and applicable to a specific company as discussed throughout this thesis. These conclusions may or may not be applicable to other small technology-oriented businesses.

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